

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	38.0 $\pm$ 6 %	1.81 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	51.7 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.10 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.2 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	53.5 Ω + 5.4 j Ω
Return Loss	- 24.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.151 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 27.03.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:1103

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.81$ S/m; $\epsilon_r = 38$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.88, 7.88, 7.88) @ 2450 MHz; Calibrated: 10.01.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 114.9 V/m; Power Drift = -0.00 dB

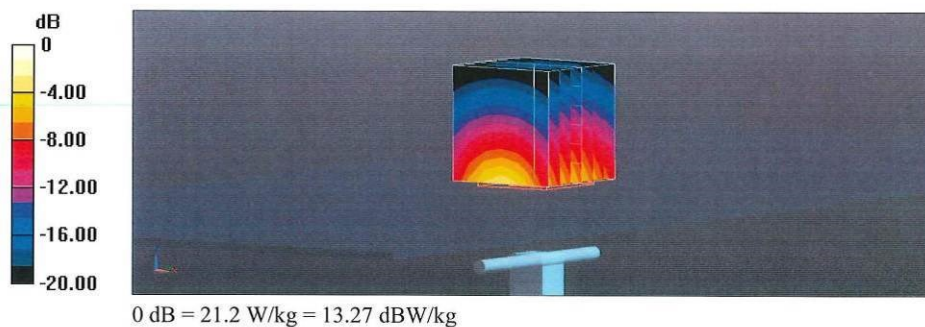
Peak SAR (extrapolated) = 25.3 W/kg

SAR(1 g) = 13.1 W/kg; SAR(10 g) = 6.10 W/kg

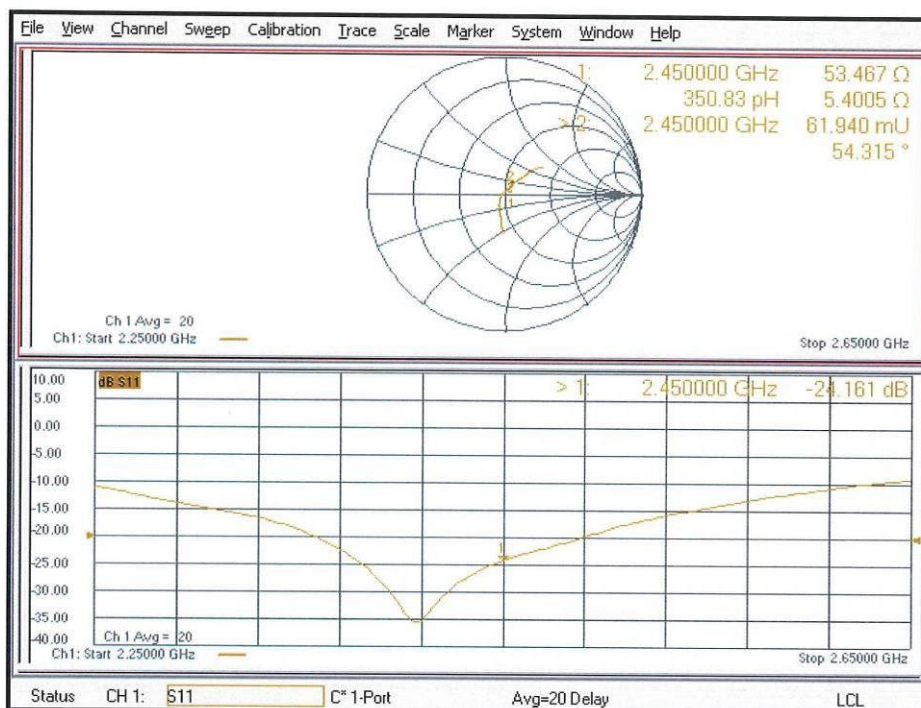
Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 51.3%

Maximum value of SAR (measured) = 21.2 W/kg



Impedance Measurement Plot for Head TSL



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Accreditation No.: **SCS 0108**

Client **BACL**
Sunnyvale USA

Certificate No. **D5GHzV2-1374_Mar23**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1374**

Calibration procedure(s) **QA CAL-22.v7**
Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: **March 27, 2023**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 3503	07-Mar-23 (No. EX3-3503_Mar23)	Mar-24
DAE4	SN: 601	19-Dec-22 (No. DAE4-601_Dec22)	Dec-23

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

Calibrated by:	Name Jeton Kastrati	Function Laboratory Technician	Signature
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Approved by:	Sven Kühn	Technical Manager	
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Issued: March 29, 2023

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: D5GHzV2-1374_Mar23

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Glossary:

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N/A	not applicable or not measured

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- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:* SAR measured at the stated antenna input power.
- SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5800 MHz $\pm$ 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	35.8 $\pm$ 6 %	4.71 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.01 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.1 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.31 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.1 W/kg $\pm$ 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	35.6 $\pm$ 6 %	5.09 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.35 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.6 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 W/kg $\pm$ 19.5 % (k=2)

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	5.24 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	81.4 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.30 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.0 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL at 5250 MHz**

Impedance, transformed to feed point	45.8 Ω - 4.5 j Ω
Return Loss	- 23.8 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	49.4 Ω + 1.5 j Ω
Return Loss	- 35.9 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	54.2 Ω + 1.5 j Ω
Return Loss	- 27.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.189 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
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DASY5 Validation Report for Head TSL

Date: 27.03.2023

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1374

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.71$ S/m; $\epsilon_r = 35.8$; $\rho = 1000$ kg/m³Medium parameters used: $f = 5600$ MHz; $\sigma = 5.09$ S/m; $\epsilon_r = 35.6$; $\rho = 1000$ kg/m³Medium parameters used: $f = 5800$ MHz; $\sigma = 5.24$ S/m; $\epsilon_r = 35.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 07.03.2023
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 19.12.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 76.14 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.9 W/kg

SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.31 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 71.4%

Maximum value of SAR (measured) = 17.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 75.28 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 30.3 W/kg

SAR(1 g) = 8.35 W/kg; SAR(10 g) = 2.38 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 68.8%

Maximum value of SAR (measured) = 19.2 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan,**dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 73.43 V/m; Power Drift = 0.01 dB

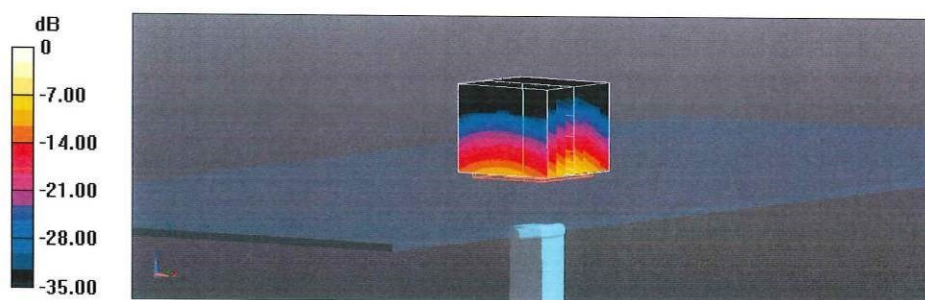
Peak SAR (extrapolated) = 31.6 W/kg

SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.3 W/kg

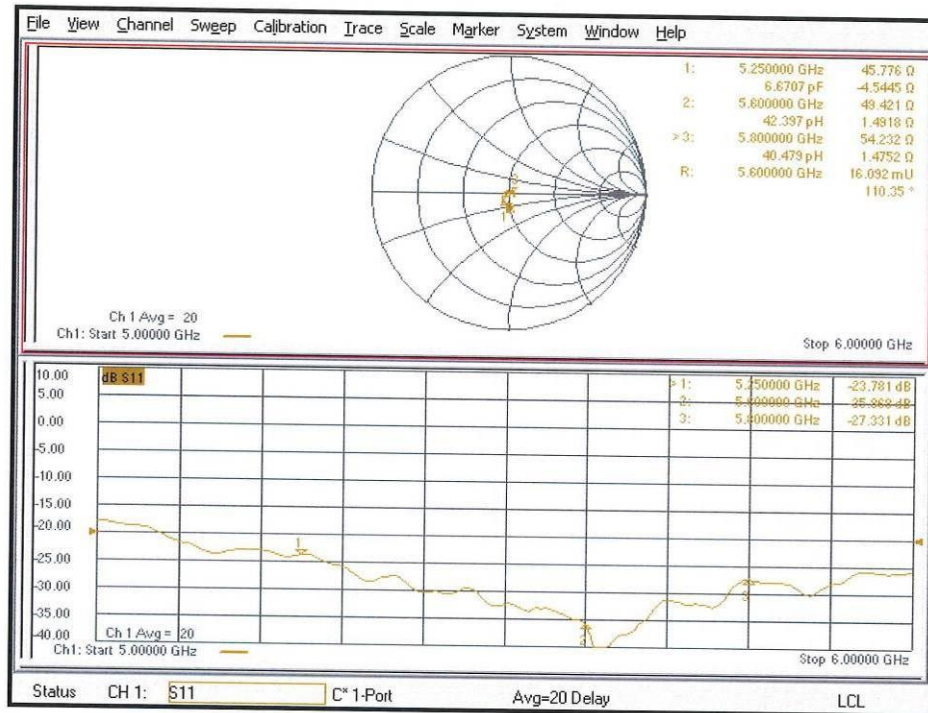
Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 66.5%

Maximum value of SAR (measured) = 19.3 W/kg



Impedance Measurement Plot for Head TSL



APPENDIX D RETURN LOSS&IMPEDANCE MEASUREMENT**Performance Qualification Report For 2450MHz SAR Dipole-1****Equipment Details:**

Description: Dipole
Manufacturer: Speag
Model Number: D2450V3
Serial Number: 1103
Calibration Date: 2024/03/27

Calibration and Checked By:

Approved By:

Bob Lu

Luke Jiang

Bob Lu

Luke Jiang

1. Equipment List & Calibration Information:

Equipment	Model	S/N	Calibration Date	Calibration Due Date
DASY5 Test Software	DASY52 52.10.2	N/A	NCR	NCR
DASY6 Measurement Server	DASY6 6.0.31	N/A	NCR	NCR
Data Acquisition Electronics	DAE4	1325	2023/09/27	2024/09/26
E-Field Probe	EX3DV4	7382	2023/09/27	2024/09/26
Mounting Device	MD4HHTV5	SD 000 H01 KA	NCR	NCR
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2023/06/08	2024/06/07
Network Analyzer Calibration Kit	50 Ω	51026	NCR	NCR
MXG Analog Signal Generator	N5181A	MY48180408	2024/01/16	2025/01/15
Microwave peak power sensor	MA24418A	12622	NCR	NCR
USB wideband power sensor	U2021XA	MY52350001	2023/06/08	2024/06/07
20dBAttenuator	N/A	N/A	NCR	NCR
Directional Coupler	855673	3307	NCR	NCR

2. Standard Requirements:

- 1) When the measured SAR does not deviates from the calibrated SAR value by more than 10%.
- 2) When the most recent return-loss result, measured at least annually, does not deviate by more than 20% from the previous measurement or meeting the required 20 dB minimum return-loss requirement.
- 3) When the most recent measurement of the real or imaginary parts of the impedance, measured at least annually, does not deviate by more than 5 Ω from the previous measurement.

3. Environmental Conditions:

TSL Temperature:	18.7 ~ 19.6°C
Ambient Temperature:	21 ~ 22.7°C
Relative Humidity:	43 ~ 48%
ATM Pressure:	101.3 kPa
Test Date:	2024/03/27

4. Test Results:

Return Loss & Impedance Measurement Results:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
2450	Head	Return Loss	25.308 dB	24.161 dB	4.747 %	±20%; ≥20dB	Pass
		Real Impedance	56.592 Ω	53.467 Ω	3.125 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	0.829 Ω	5.400 Ω	-4.571 Ω	≤ 5 Ω	Pass

Liquid Verification Results:

Frequency (MHz)	Liquid Type	Liquid Parameter		Target Value		Delta (%)		Tolerance (%)
		ε _r	σ' (S/m)	ε _r	σ' (S/m)	Δε _r	Δσ'	
2450	Simulated Tissue Liquid Head	38.866	1.794	39.20	1.80	-0.85	-0.33	±5

System Accuracy Check Results:

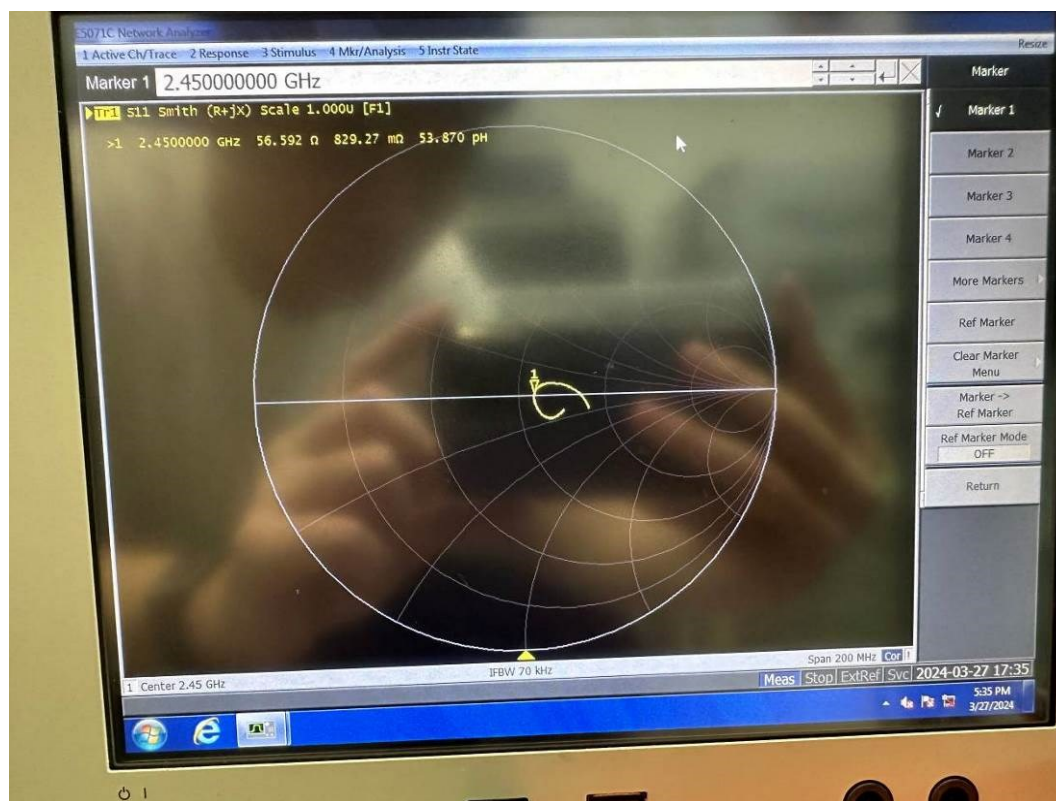
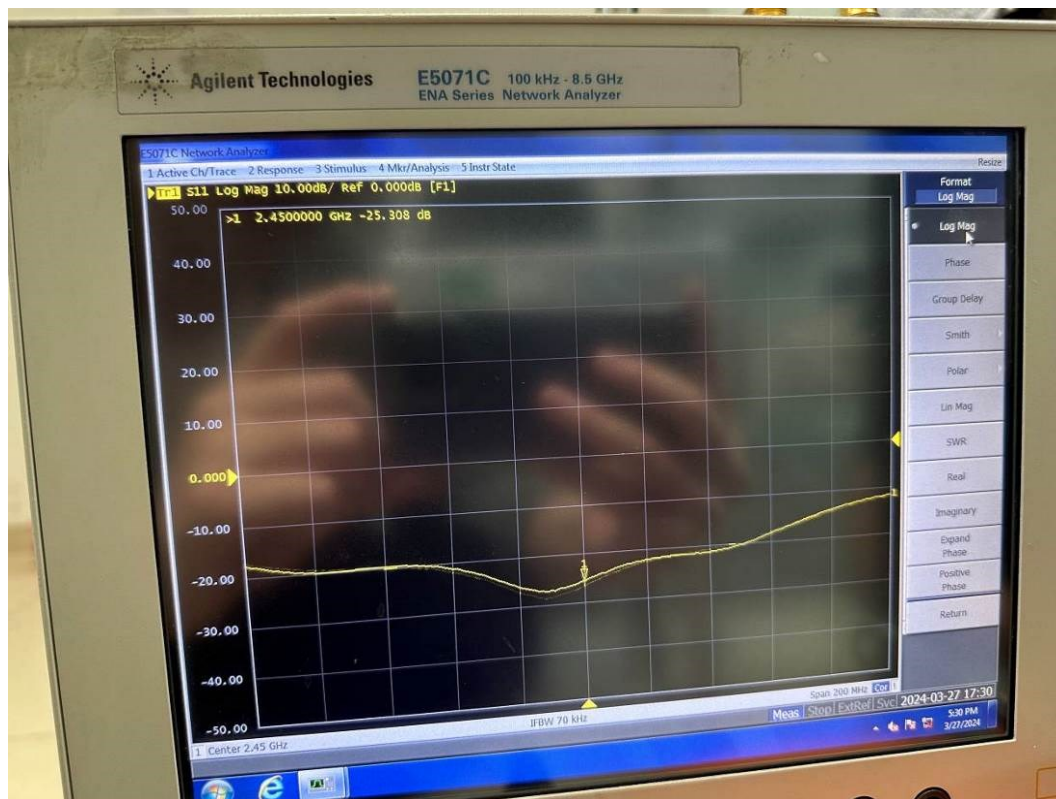
Frequency Band (MHz)	Liquid Type	Input Power (mW)	Measured SAR (W/kg)		Normalized to 1W (W/kg)	Target Value (W/Kg)	Delta (%)	Tolerance (%)
2450	Head	100	1g	5.04	50.4	51.7	-2.515	±10
			10g	2.41	24.1	24.2	-0.413	±10

Note:

- Return Loss Deviation = (Measured-Target)/Target×100%
- The target values above please refer to 2450MHz dipole calibration certificate (Certificate No.: D2450V2-1103_Mar23), which was issued by SPEAG.

5. Test Plot & System Validation Data:

Dipole, 2450MHz, 1103



System Performance 2450 MHz Head**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 1103**

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.794$ S/m; $\epsilon_r = 38.866$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7382; ConvF(7.89, 7.89, 7.89) @ 2450 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 9/27/2023
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 2450MHz Pin=100mW/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 8.12 W/kg

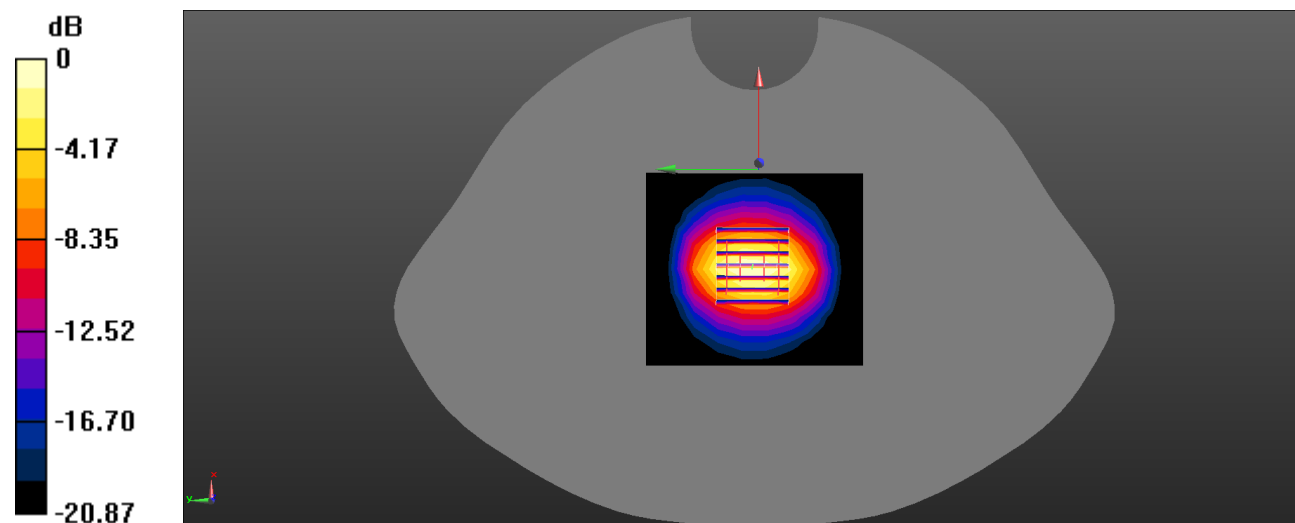
Configuration/Head 2450MHz Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.61 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 9.93 W/kg

SAR(1 g) = 5.04 W/kg; SAR(10 g) = 2.41 W/kg

Maximum value of SAR (measured) = 8.23 W/kg



0 dB = 8.23 W/kg = 9.15 dBW/kg

Performance Qualification Report For 2450MHz SAR Dipole-2**Equipment Details:**

Description: Dipole
Manufacturer: Speag
Model Number: D2450V3
Serial Number: 1103
Calibration Date: 2025/03/26

Calibration and Checked By:

Approved By:

Bob Lu

Luke Jiang

Bob Lu

Luke Jiang

1. Equipment List & Calibration Information:

Equipment	Model	S/N	Calibration Date	Calibration Due Date
DASY5 Test Software	DASY52 52.10.2	N/A	NCR	NCR
DASY6 Measurement Server	DASY6 6.0.31	N/A	NCR	NCR
Data Acquisition Electronics	DAE4	1325	2024/10/08	2025/10/07
Dosimetric E-field Probes	EX3DV4	7896	2024/11/07	2025/11/06
Mounting Device	MD4HHTV5	SD 000 H01 KA	NCR	NCR
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2024/05/21	2025/05/20
Network Analyzer Calibration Kit	50 Ω	51026	NCR	NCR
MXG Analog Signal Generator	N5181A	MY48180408	2024/12/04	2025/12/03
Microwave peak power sensor	MA24418A	12622	NCR	NCR
USB wideband power sensor	U2021XA	MY52350001	2024/05/21	2025/05/20
20dBAttenuator	N/A	N/A	NCR	NCR
Directional Coupler	855673	3307	NCR	NCR

2. Standard Requirements:

- 1) When the measured SAR does not deviates from the calibrated SAR value by more than 10%.
- 2) When the most recent return-loss result, measured at least annually, does not deviate by more than 20% from the previous measurement or meeting the required 20 dB minimum return-loss requirement.
- 3) When the most recent measurement of the real or imaginary parts of the impedance, measured at least annually, does not deviate by more than 5 Ω from the previous measurement.

3. Environmental Conditions:

TSL Temperature:	18.2 ~ 19.6°C
Ambient Temperature:	18.8 ~ 20.7°C
Relative Humidity:	50 ~ 63%
ATM Pressure:	98.1 kPa
Test Date:	2025/03/26

4. Test Results:

Return Loss & Impedance Measurement Results:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
2450	Head	Return Loss	23.878 dB	24.161 dB	-1.171 %	±20%; ≥20dB	Pass
		Real Impedance	51.498 Ω	53.467 Ω	1.969 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	6.333 Ω	5.400 Ω	0.933 Ω	≤ 5 Ω	Pass

Liquid Verification Results:

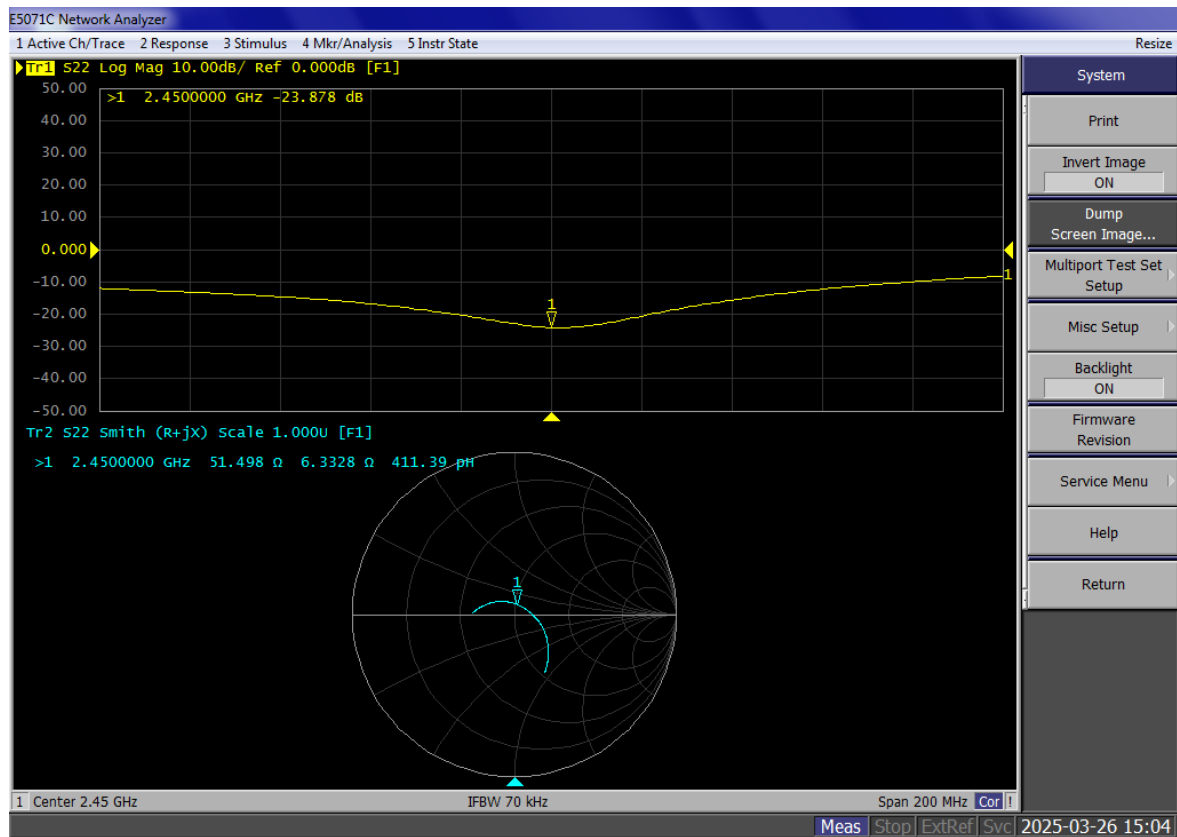
Frequency (MHz)	Liquid Type	Liquid Parameter		Target Value		Delta (%)		Tolerance (%)
		ε _r	σ' (S/m)	ε _r	σ' (S/m)	Δε _r	Δσ'	
2450	Simulated Tissue Liquid Head	38.549	1.765	39.20	1.80	-1.66	-1.94	±5

System Accuracy Check Results:

Frequency Band (MHz)	Liquid Type	Input Power (mW)	Measured SAR (W/kg)		Normalized to 1W (W/kg)	Target Value (W/Kg)	Delta (%)	Tolerance (%)
2450	Head	100	1g	5.18	51.8	51.7	0.193	±10
			10g	2.62	26.2	24.2	8.264	±10

Note:

- Return Loss Deviation = (Measured-Target)/Target×100%
- The target values above please refer to 2450MHz dipole calibration certificate (Certificate No.: D2450V2-1103_Mar23), which was issued by SPEAG.

5. Test Plot & System Validation Data:**Dipole, 2450MHz, 1103**

System Performance 2450 MHz Head**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: 1103**

Communication System: UID 0, CW (0); Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.765$ S/m; $\epsilon_r = 38.549$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7896; ConvF(6.54, 6.85, 6.86) @ 2450 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 10/8/2024
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 2450MHz Pin=100mW/Area Scan (9x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 7.39 W/kg

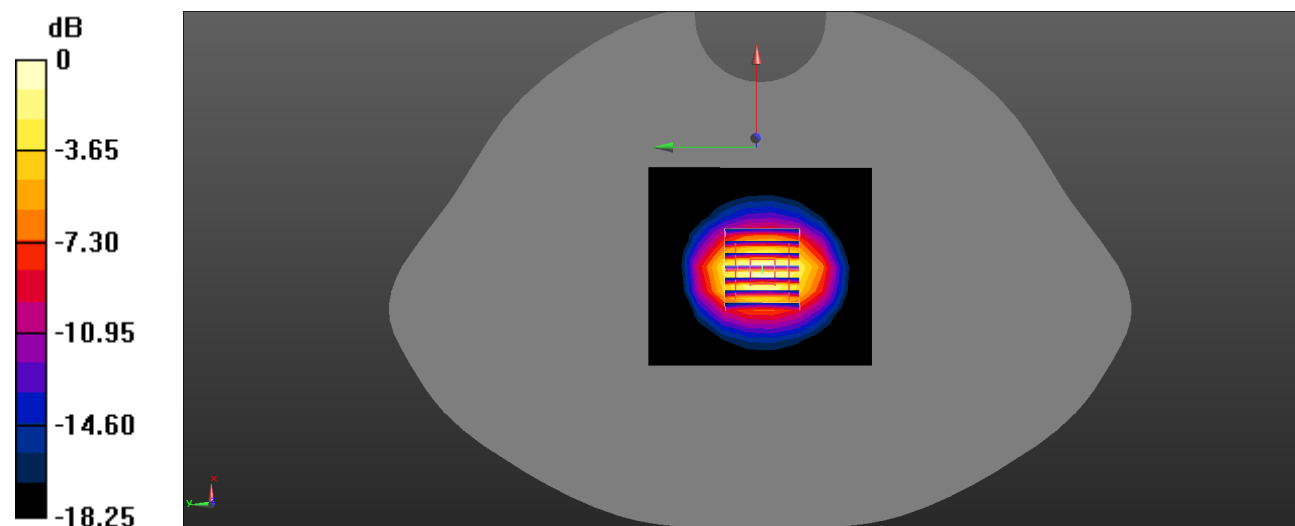
Configuration/Head 2450MHz Pin=100mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 59.58 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 9.03 W/kg

SAR(1 g) = 5.18 W/kg; SAR(10 g) = 2.62 W/kg

Maximum value of SAR (measured) = 7.86 W/kg



0 dB = 7.86 W/kg = 8.95 dBW/kg

Performance Qualification Report For 5GHz SAR Dipole-1

Equipment Details:

Description: Dipole
Manufacturer: Speag
Model Number: D5GHzV2
Serial Number: 1374
Calibration Date: 2024/03/27

Calibration and Checked By:

Approved By:

Bob Lu

Luke Jiang

Bob Lu

Luke Jiang

1. Equipment List & Calibration Information:

Equipment	Model	S/N	Calibration Date	Calibration Due Date
DASY5 Test Software	DASY52 52.10.2	N/A	NCR	NCR
DASY6 Measurement Server	DASY6 6.0.31	N/A	NCR	NCR
Data Acquisition Electronics	DAE4	1325	2023/09/27	2024/09/26
E-Field Probe	EX3DV4	7382	2023/09/27	2024/09/26
Mounting Device	MD4HHTV5	SD 000 H01 KA	NCR	NCR
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2023/06/08	2024/06/07
Network Analyzer Calibration Kit	50 Ω	51026	NCR	NCR
MXG Analog Signal Generator	N5181A	MY48180408	2024/01/16	2025/01/15
Microwave peak power sensor	MA24418A	12622	NCR	NCR
USB wideband power sensor	U2021XA	MY52350001	2023/06/08	2024/06/07
20dBAttenuator	N/A	N/A	NCR	NCR
Directional Coupler	855673	3307	NCR	NCR

2. Standard Requirements:

- 1) When the measured SAR does not deviates from the calibrated SAR value by more than 10%.
- 2) When the most recent return-loss result, measured at least annually, does not deviate by more than 20% from the previous measurement or meeting the required 20 dB minimum return-loss requirement.
- 3) When the most recent measurement of the real or imaginary parts of the impedance, measured at least annually, does not deviate by more than 5 Ω from the previous measurement.

3. Environmental Conditions:

TSL Temperature:	18.7 ~ 19.6°C
Ambient Temperature:	21 ~ 22.7°C
Relative Humidity:	43 ~ 48%
ATM Pressure:	101.3 kPa
Test Date:	2024/03/27

4. Test Results:

Return Loss & Impedance Measurement Results:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
5250	Head	Return Loss	22.303 dB	23.781 dB	-6.215 %	±20%; ≥20dB	Pass
		Real Impedance	44.252 Ω	45.776 Ω	1.524 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	-2.702 Ω	-4.545 Ω	1.843 Ω	≤ 5 Ω	Pass
5600	Head	Return Loss	34.639 dB	35.868 dB	3.426%	±20%; ≥20dB	Pass
		Real Impedance	47.686 Ω	43.421 Ω	4.265 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	-0.211 Ω	1.492 Ω	1.703 Ω	≤ 5 Ω	Pass
5800	Head	Return Loss	29.943 dB	27.331 dB	9.557 %	±20%; ≥20dB	Pass
		Real Impedance	50.363 Ω	54.232 Ω	-3.869 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	-2.534 Ω	1.475 Ω	-4.009 Ω	≤ 5 Ω	Pass

Liquid Verification Results:

Frequency (MHz)	Liquid Type	Liquid Parameter		Target Value		Delta (%)		Tolerance (%)
		ε _r	σ (S/m)	ε _r	σ (S/m)	Δε _r	Δσ	
5250	Simulated Tissue Liquid Head	34.729	4.650	35.95	4.71	-3.40	-1.27	±5
5600	Simulated Tissue Liquid Head	35.785	5.099	35.50	5.07	0.80	0.57	±5
5800	Simulated Tissue Liquid Head	34.327	5.233	35.30	5.27	-2.76	-0.70	±5

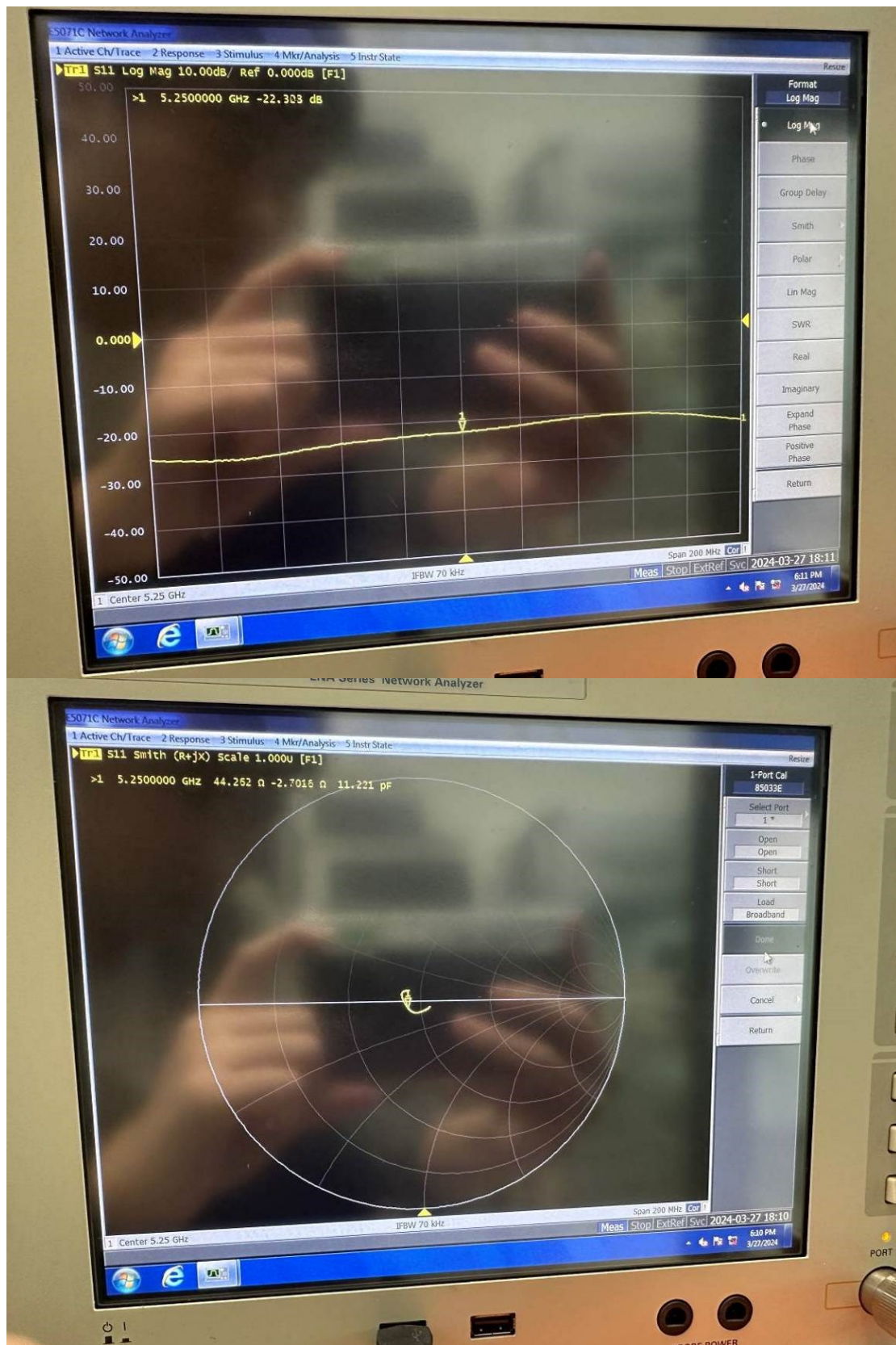
System Accuracy Check Results:

Frequency Band (MHz)	Liquid Type	Input Power (mW)	Measured SAR (W/kg)		Normalized to 1W (W/kg)	Target Value (W/Kg)	Delta (%)	Tolerance (%)
5250	Head	100	1g	8.14	81.4	80.1	1.623	±10
			10g	2.41	24.1	23.1	4.329	±10
5600	Head	100	1g	7.68	76.8	83.6	-8.134	±10
			10g	2.23	22.3	23.8	-6.303	±10
5800	Head	100	1g	7.97	79.7	81.4	-2.088	±10
			10g	2.32	23.2	23.0	0.870	±10

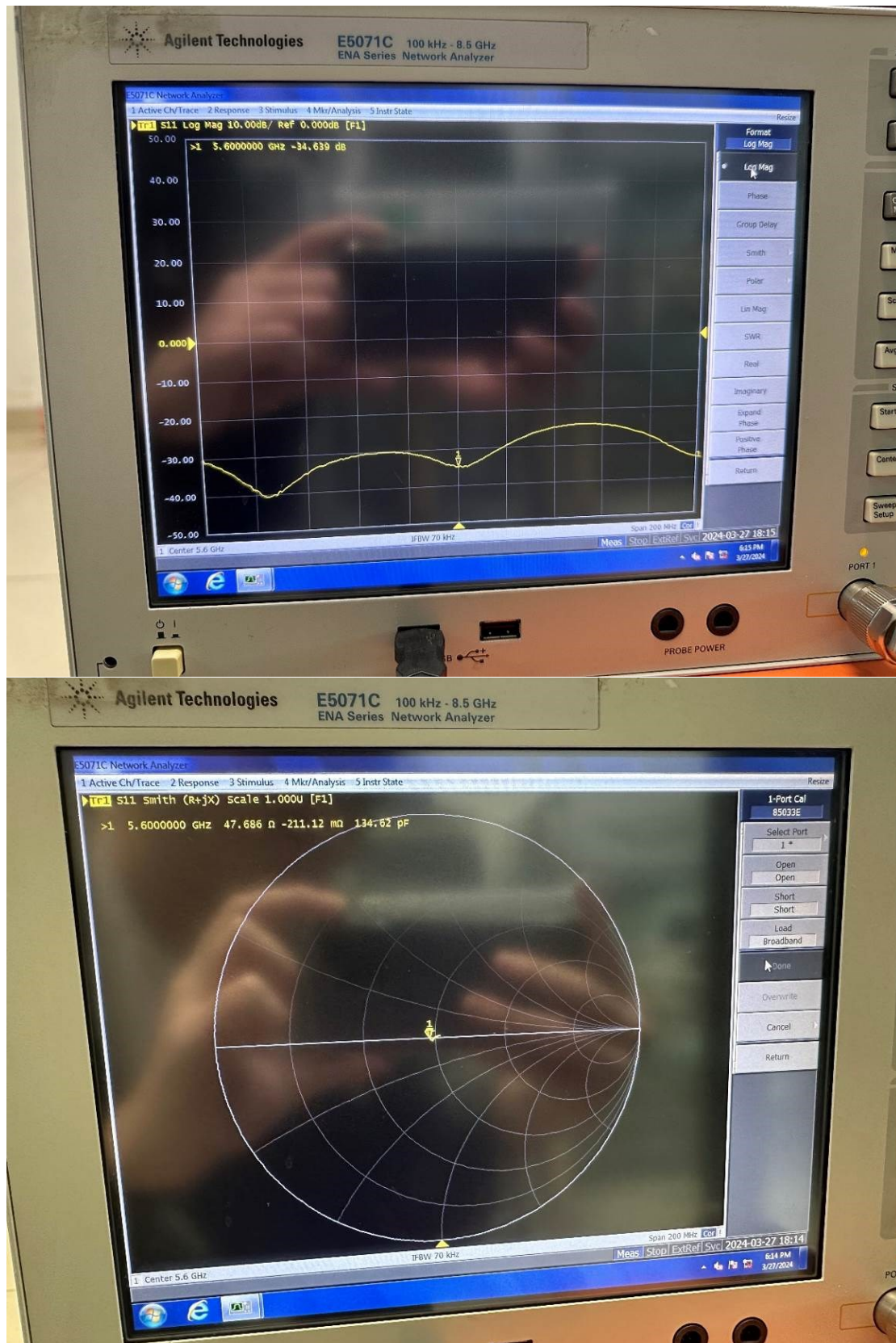
Note:

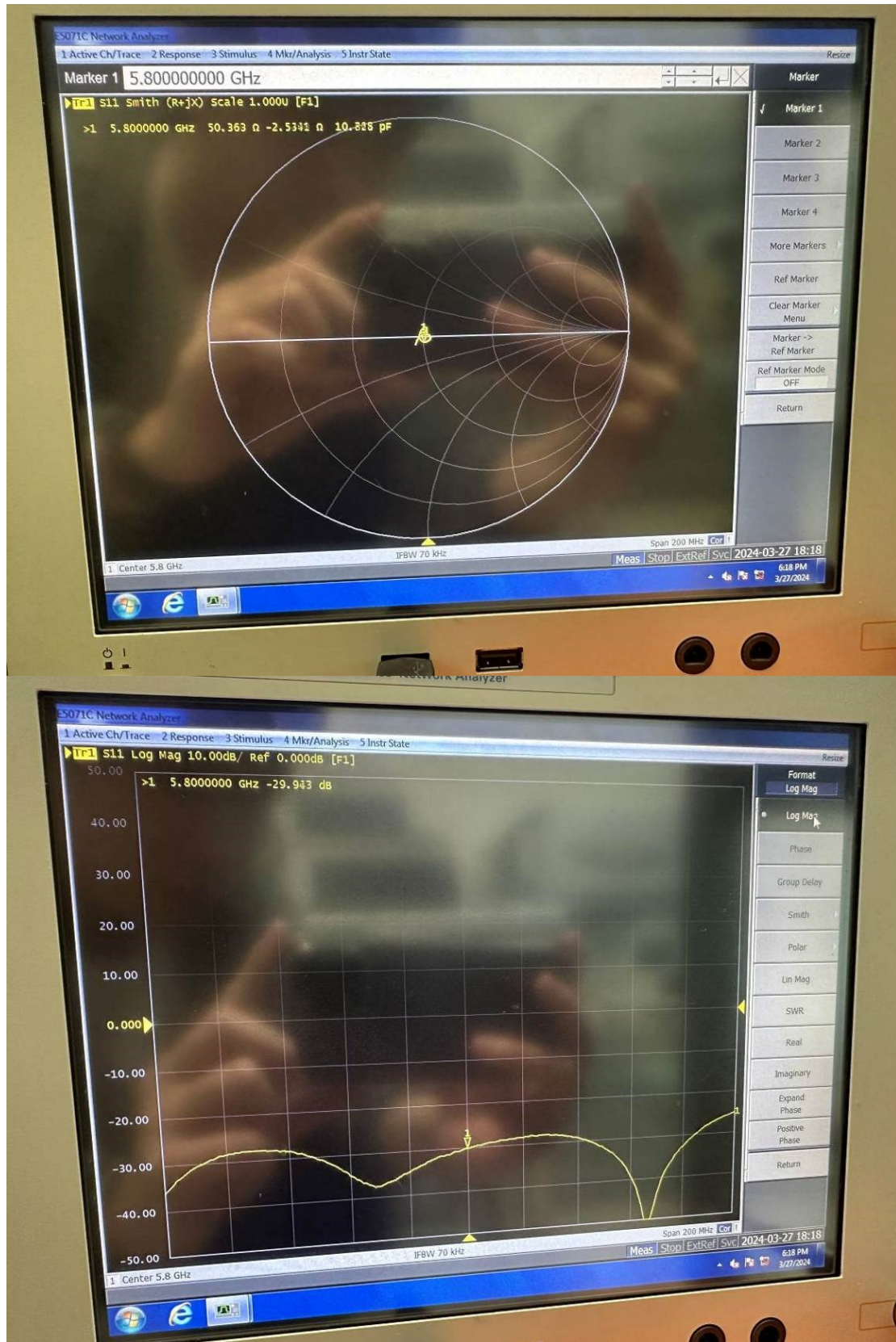
1. Return Loss Deviation = (Measured-Target)/Target×100%

2. The target values above please refer to 5GHz dipole calibration certificate (Certificate No.: D5GHz-1374_Mar23), which was issue by SPEAG.

5. Test Plot & System Validation Data:**Dipole, 5250MHz, 1374**

Dipole, 5600MHz, 1374



Dipole, 5800MHz, 1374

System Performance 5250 MHz Head**DUT: Dipole D5GHz; Type: D5GHzV2; Serial: 1374**

Communication System: UID 0, CW (0); Frequency: 5250 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.65$ S/m; $\epsilon_r = 34.729$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7382; ConvF(5.62, 5.62, 5.62) @ 5250 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 9/27/2023
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 5250MHz Pin=100mW/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 17.7 W/kg

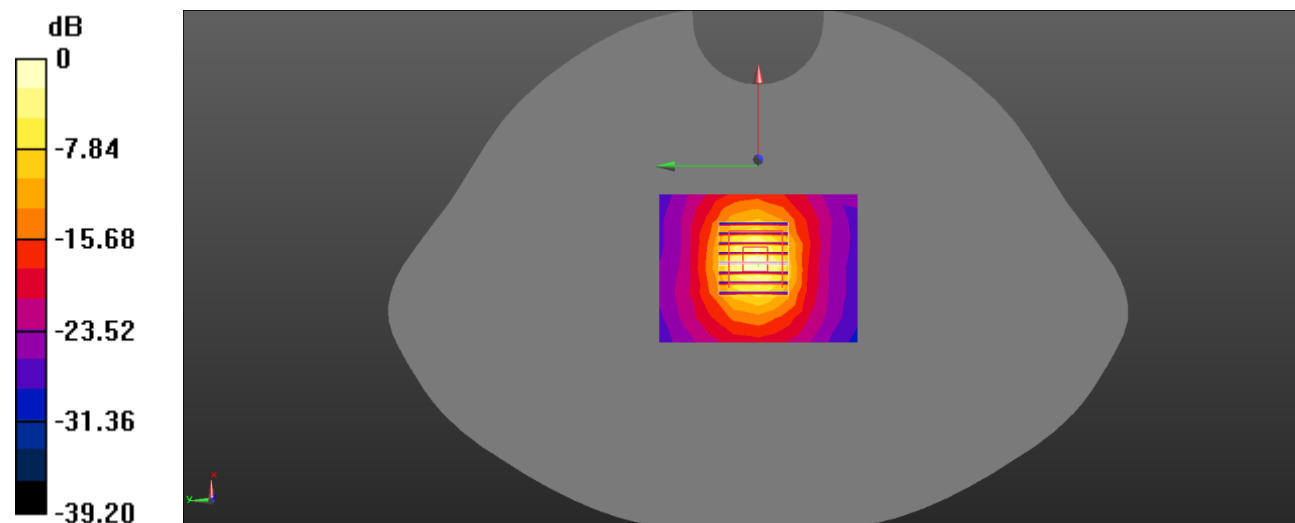
Configuration/Head 5250MHz Pin=100mW/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 44.86 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 28.0 W/kg

SAR(1 g) = 8.14 W/kg; SAR(10 g) = 2.41 W/kg

Maximum value of SAR (measured) = 18.5 W/kg



0 dB = 18.5 W/kg = 12.67 dBW/kg

System Performance 5600 MHz Head**DUT: Dipole D5GHz; Type: D5GHzV2; Serial: 1374**

Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.099$ S/m; $\epsilon_r = 35.785$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7382; ConvF(5.1, 5.1, 5.1) @ 5600 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 9/27/2023
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 5600MHz Pin=100mW/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 18.9 W/kg

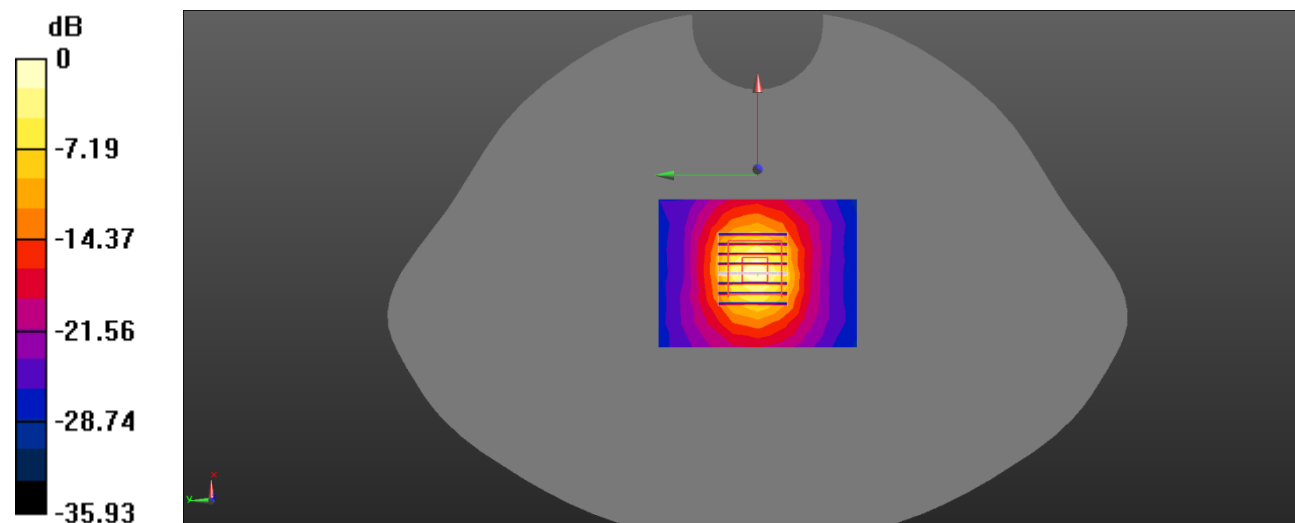
Configuration/Head 5600MHz Pin=100mW/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 42.74 V/m; Power Drift = -0.12 dB

Peak SAR (extrapolated) = 28.6 W/kg

SAR(1 g) = 7.68 W/kg; SAR(10 g) = 2.23 W/kg

Maximum value of SAR (measured) = 17.7 W/kg



0 dB = 17.7 W/kg = 12.48 dBW/kg

System Performance 5800 MHz Head**DUT: Dipole D5GHz; Type: D5GHzV2; Serial: 1374**

Communication System: UID 0, CW (0); Frequency: 5800 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5800$ MHz; $\sigma = 5.233$ S/m; $\epsilon_r = 34.327$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7382; ConvF(5.08, 5.08, 5.08) @ 5800 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 9/27/2023
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 5800MHz Pin=100mW/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 19.6 W/kg

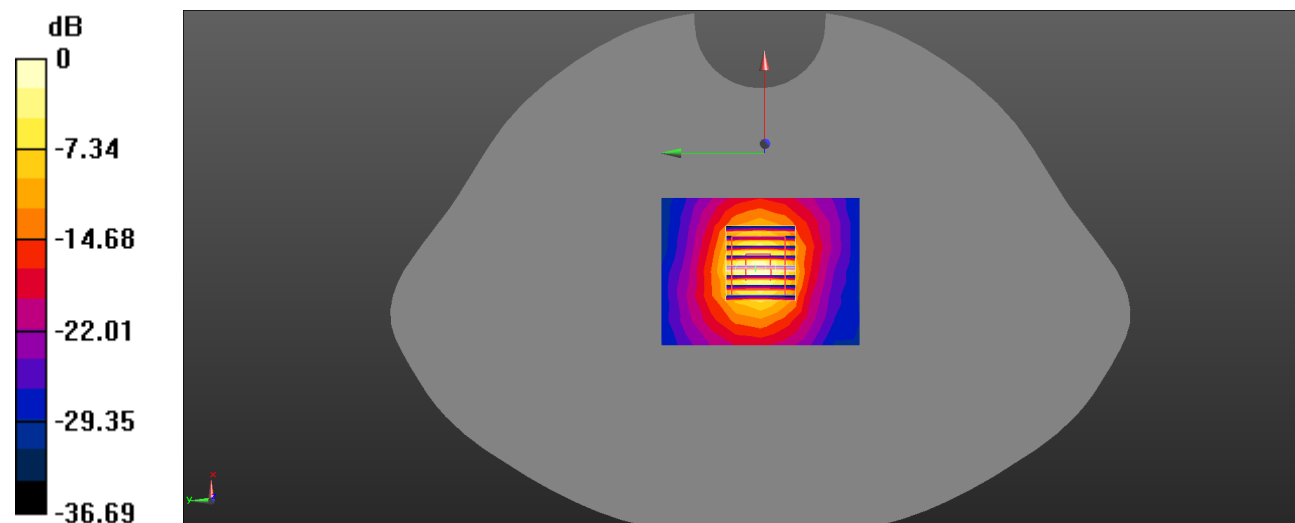
Configuration/Head 5800MHz Pin=100mW/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 41.74 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 31.8 W/kg

SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.32 W/kg

Maximum value of SAR (measured) = 19.2 W/kg



0 dB = 19.2 W/kg = 12.83 dBW/kg

Performance Qualification Report For 5GHz SAR Dipole-2

Equipment Details:

Description: Dipole
Manufacturer: Speag
Model Number: D5GHzV2
Serial Number: 1374
Calibration Date: 2025/03/26

Calibration and Checked By:

Approved By:

Bob Lu

Luke Jiang

Bob Lu

Luke Jiang

1. Equipment List & Calibration Information:

Equipment	Model	S/N	Calibration Date	Calibration Due Date
DASY5 Test Software	DASY52 52.10.2	N/A	NCR	NCR
DASY6 Measurement Server	DASY6 6.0.31	N/A	NCR	NCR
Data Acquisition Electronics	DAE4	1325	2024/10/08	2025/10/07
Dosimetric E-field Probes	EX3DV4	7896	2024/11/07	2025/11/06
Mounting Device	MD4HHTV5	SD 000 H01 KA	NCR	NCR
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Simulated Tissue Liquid Head	HBBL600-10000V6	2200808-2	Each Time	
SAM Twin Phantom	SAM-Twin V8.0	1962	NCR	NCR
Network Analyzer	E5071C	SER MY46519680	2024/05/21	2025/05/20
Network Analyzer Calibration Kit	50 Ω	51026	NCR	NCR
MXG Analog Signal Generator	N5181A	MY48180408	2024/12/04	2025/12/03
Microwave peak power sensor	MA24418A	12622	NCR	NCR
USB wideband power sensor	U2021XA	MY52350001	2024/05/21	2025/05/20
20dBAttenuator	N/A	N/A	NCR	NCR
Directional Coupler	855673	3307	NCR	NCR

2. Standard Requirements:

- 1) When the measured SAR does not deviates from the calibrated SAR value by more than 10%.
- 2) When the most recent return-loss result, measured at least annually, does not deviate by more than 20% from the previous measurement or meeting the required 20 dB minimum return-loss requirement.
- 3) When the most recent measurement of the real or imaginary parts of the impedance, measured at least annually, does not deviate by more than 5 Ω from the previous measurement.

3. Environmental Conditions:

TSL Temperature:	18.2 ~ 19.6°C
Ambient Temperature:	18.8 ~ 20.7°C
Relative Humidity:	50 ~ 63%
ATM Pressure:	98.1 kPa
Test Date:	2025/03/26

4. Test Results:

Return Loss & Impedance Measurement Results:

Frequency (MHz)	Simulated Liquid	Parameter	Measured Value	Target Value	Deviation	Reference Range	Results
5250	Head	Return Loss	21.310 dB	23.781 dB	-10.391 %	±20%; ≥20dB	Pass
		Real Impedance	49.591 Ω	45.776 Ω	3.815 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	-8.589 Ω	-4.545 Ω	4.044 Ω	≤ 5 Ω	Pass
5600	Head	Return Loss	35.147 dB	35.868 dB	-2.010 %	±20%; ≥20dB	Pass
		Real Impedance	45.173 Ω	43.421 Ω	1.752 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	-1.343 Ω	1.492 Ω	2.835 Ω	≤ 5 Ω	Pass
5800	Head	Return Loss	25.866 dB	27.331 dB	-5.360 %	±20%; ≥20dB	Pass
		Real Impedance	51.957 Ω	54.232 Ω	2.275 Ω	≤ 5 Ω	Pass
		Imaginary Impedance	4.812 Ω	1.475 Ω	3.337 Ω	≤ 5 Ω	Pass

Liquid Verification Results:

Frequency (MHz)	Liquid Type	Liquid Parameter		Target Value		Delta (%)		Tolerance (%)
		ε _r	σ (S/m)	ε _r	σ (S/m)	Δε _r	Δσ	
5250	Simulated Tissue Liquid Head	34.761	4.617	35.95	4.71	-3.31	-1.97	±5
5600	Simulated Tissue Liquid Head	35.202	5.116	35.50	5.07	-0.84	0.91	±5
5800	Simulated Tissue Liquid Head	35.998	5.089	35.30	5.27	1.98	-3.43	±5

System Accuracy Check Results:

Frequency Band (MHz)	Liquid Type	Input Power (mW)	Measured SAR (W/kg)		Normalized to 1W (W/kg)	Target Value (W/Kg)	Delta (%)	Tolerance (%)
5250	Head	100	1g	7.97	79.7	80.1	-0.499	±10
			10g	2.41	24.1	23.1	4.329	±10
5600	Head	100	1g	7.87	78.7	83.6	-5.861	±10
			10g	2.34	23.4	23.8	-1.681	±10
5800	Head	100	1g	8.38	83.8	81.4	2.948	±10
			10g	2.49	24.9	23.0	8.261	±10

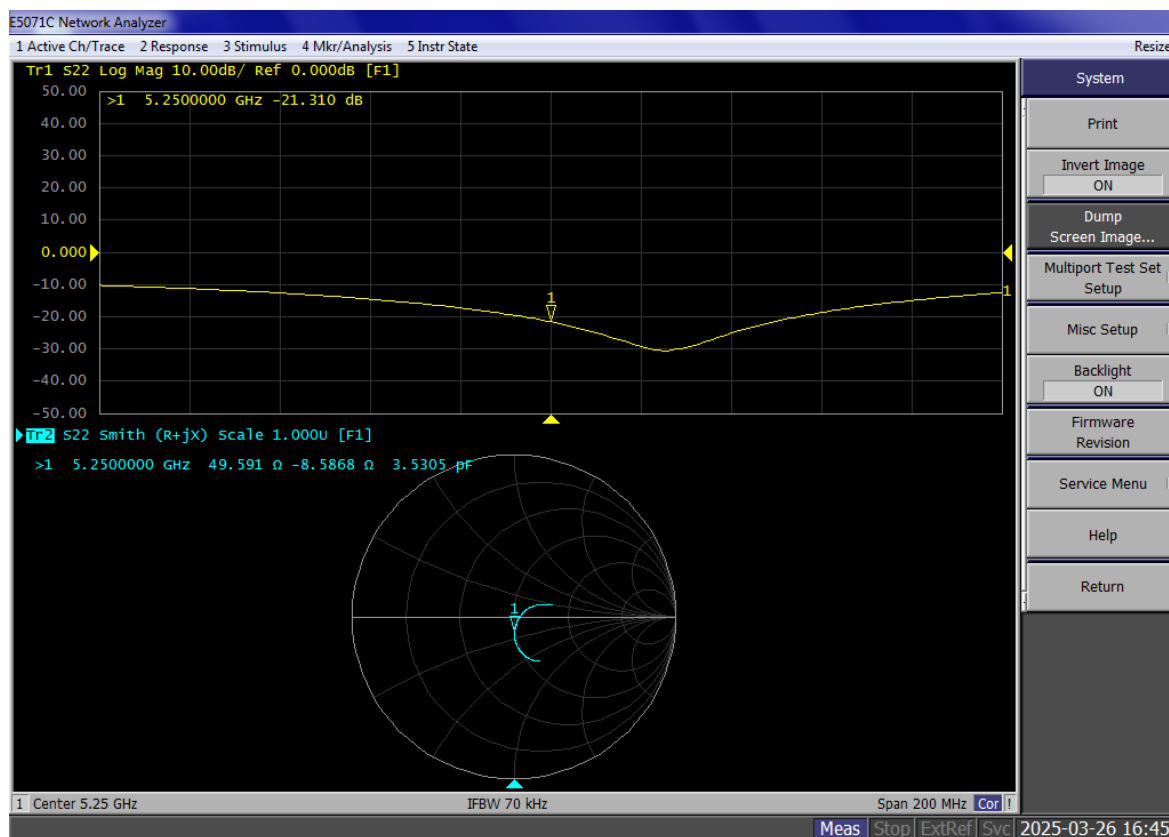
Note:

1. Return Loss Deviation = (Measured-Target)/Target×100%

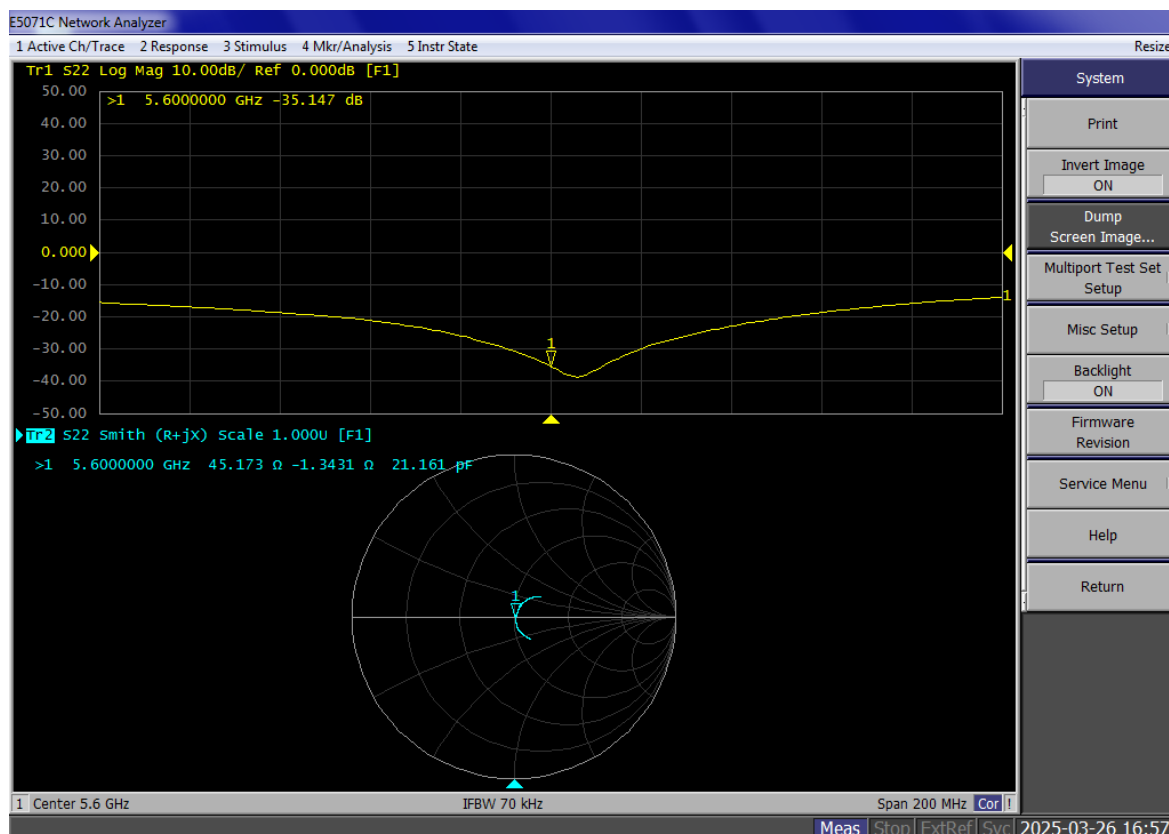
2. The target values above please refer to 5GHz dipole calibration certificate (Certificate No.: D5GHz-1374_Mar23), which was issue by SPEAG.

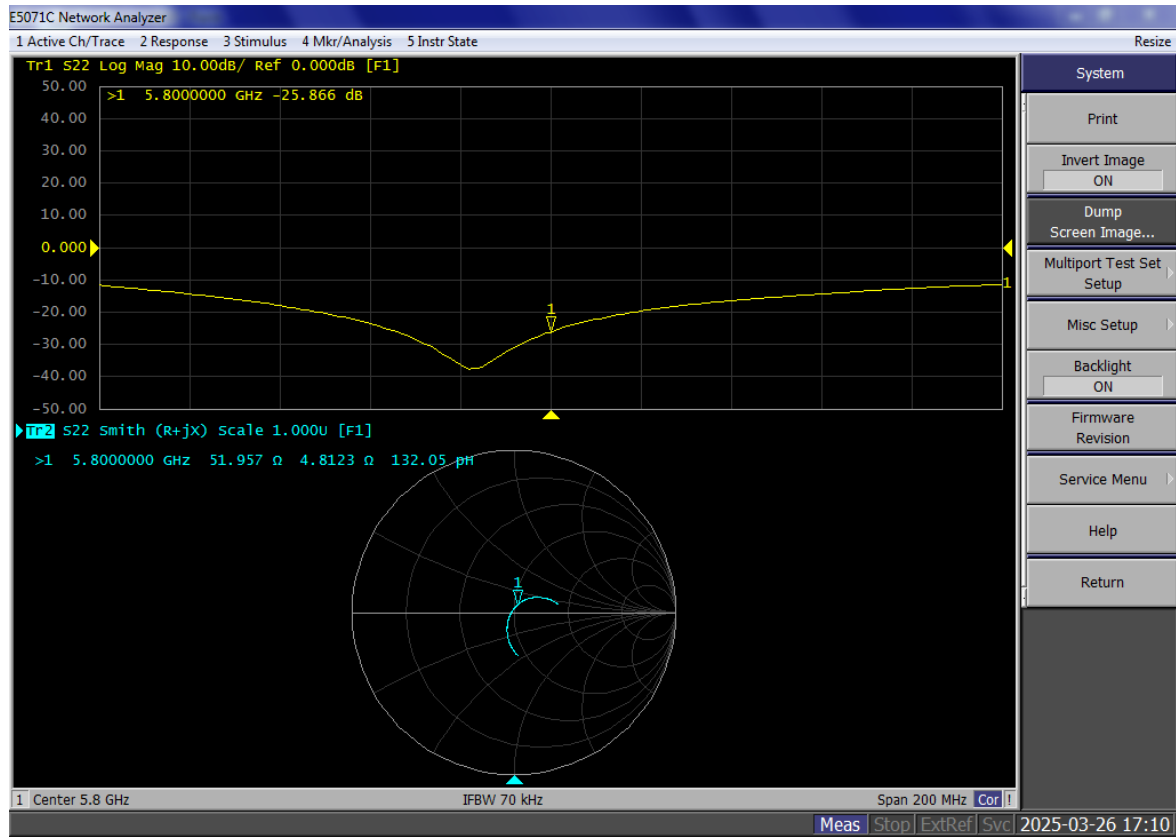
5. Test Plot & System Validation Data:

Dipole, 5250MHz, 1374



Dipole, 5600MHz, 1374



Dipole, 5800MHz, 1374

System Performance 5250 MHz Head**DUT: Dipole D5GHz; Type: D5GHzV2; Serial: 1374**

Communication System: UID 0, CW (0); Frequency: 5250 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.617$ S/m; $\epsilon_r = 34.761$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7896; ConvF(4.86, 5.09, 5.09) @ 5250 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 10/8/2024
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 5250MHz Pin=100mW/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 18.5 W/kg

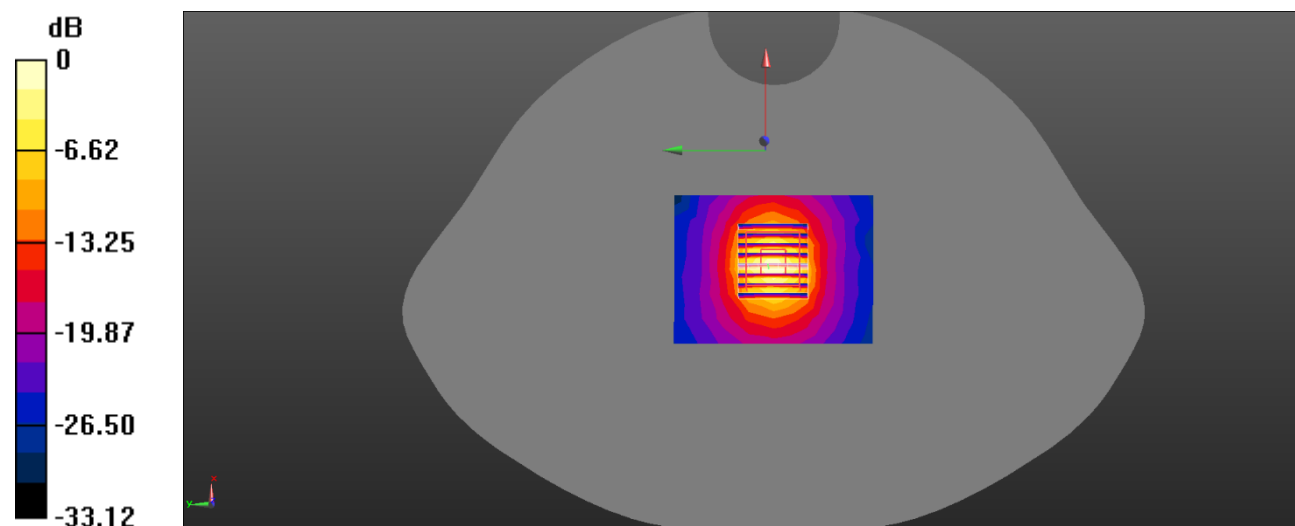
Configuration/Head 5250MHz Pin=100mW/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 46.17 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 26.8 W/kg

SAR(1 g) = 7.97 W/kg; SAR(10 g) = 2.41 W/kg

Maximum value of SAR (measured) = 17.0 W/kg



0 dB = 17.0 W/kg = 12.30 dBW/kg

System Performance 5600 MHz Head**DUT: Dipole D5GHz; Type: D5GHzV2; Serial: 1374**

Communication System: UID 0, CW (0); Frequency: 5600 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5600$ MHz; $\sigma = 5.116$ S/m; $\epsilon_r = 35.202$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7896; ConvF(4.52, 4.74, 4.74) @ 5600 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 10/8/2024
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 5600MHz Pin=100mW/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 18.5 W/kg

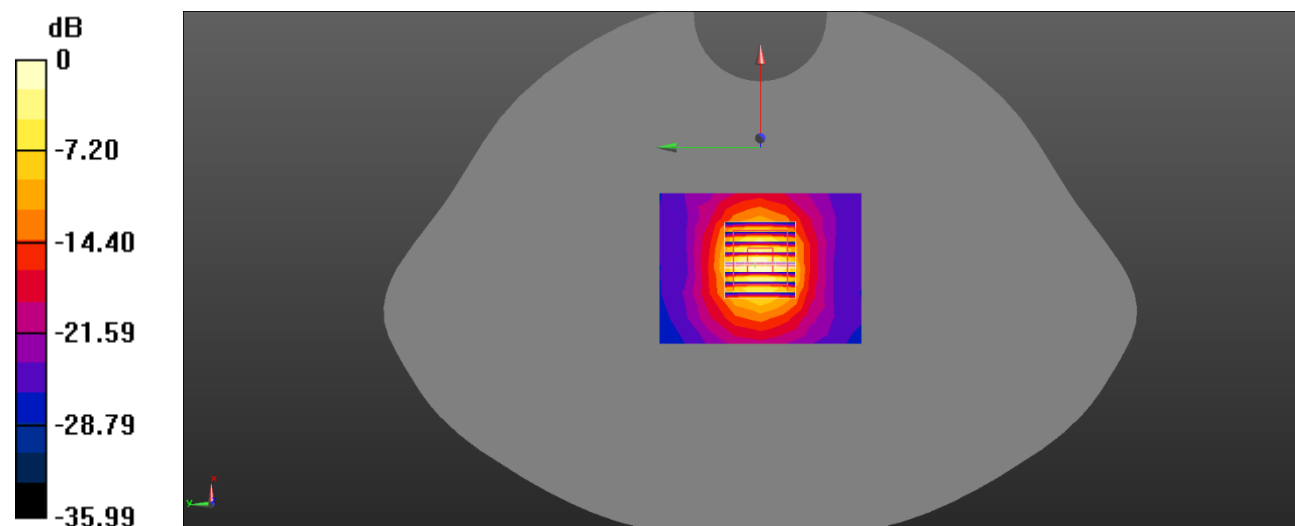
Configuration/Head 5600MHz Pin=100mW/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 42.29 V/m; Power Drift = -0.12 dB

Peak SAR (extrapolated) = 29.1 W/kg

SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.34 W/kg

Maximum value of SAR (measured) = 17.3 W/kg



0 dB = 17.3 W/kg = 12.38 dBW/kg

System Performance 5800 MHz Head**DUT: Dipole D5GHz; Type: D5GHzV2; Serial: 1374**

Communication System: UID 0, CW (0); Frequency: 5800 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 5800$ MHz; $\sigma = 5.089$ S/m; $\epsilon_r = 35.998$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 - SN7896; ConvF(4.56, 4.78, 4.78) @ 5800 MHz;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1325; Calibrated: 10/8/2024
- Phantom: SAM-Twin V8.0 P1aP2a; Type: QD 000 P41 AA ; Serial: 1962
- Measurement SW: DASY52, Version 52.10 (2);

Configuration/Head 5800MHz Pin=100mW/Area Scan (11x13x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 19.7 W/kg

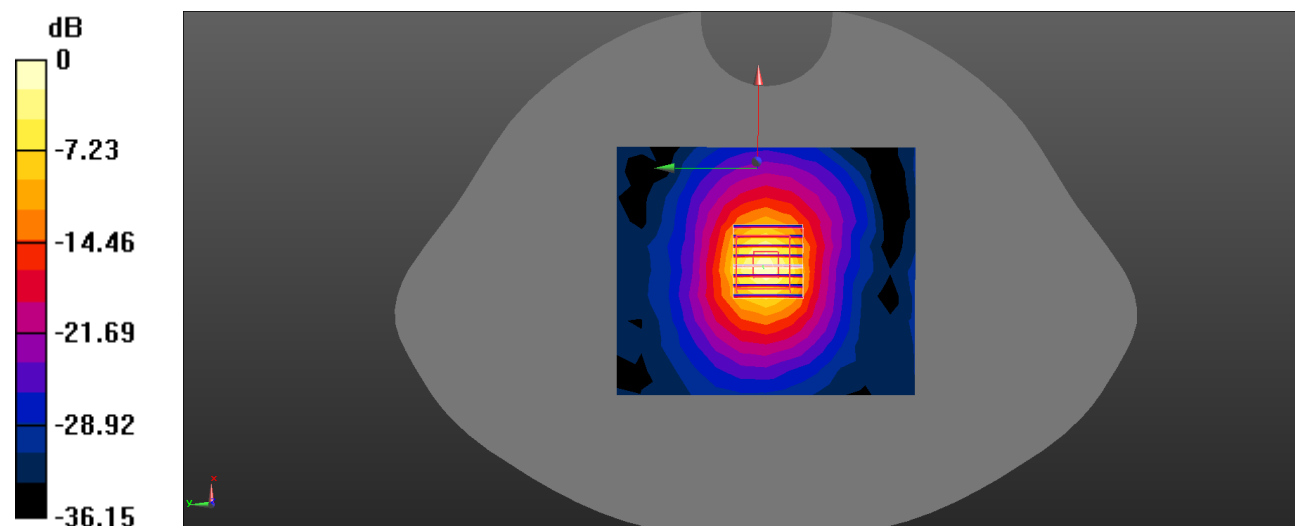
Configuration/Head 5800MHz Pin=100mW/Zoom Scan (8x8x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 43.93 V/m; Power Drift = -0.09 dB

Peak SAR (extrapolated) = 31.6 W/kg

SAR(1 g) = 8.38 W/kg; SAR(10 g) = 2.49 W/kg

Maximum value of SAR (measured) = 19.6 W/kg

****** END OF REPORT ******